DEVELOPMENT AND APPLICATION OF MAGNETIC-FIELD-FREE ATOMIC-RESOLUTION ELECTRON MICROSCOPY

N. Shibata[1,2,3]

[1] Institute of Engineering Innovation, The University of Tokyo, Japan
[2] Nanostructures Research Laboratory, Japan Fine Ceramic Center, Japan
E-mail: *shibata@sigma.t.u-tokyo.ac.jp*

Scanning transmission electron microscopy (STEM) is a powerful technique for directly visualizing atomic-scale structures inside materials and devices. In the state-of-the-art STEM, a probe size of less than 0.5Å in diameter has been experimentally realized. Now, the following interesting question arises: beyond just atoms, what might become observable by using such fine electron probes? One answer to this question may be exploring new possibilities in phase contrast imaging of STEM [1]. By using elaborate detectors, we can not only image single atoms, but can also image electric field distribution inside single atoms [2]. It then becomes tempting to directly observe magnetic fields of atoms. However, atomic-resolution observation of magnetic materials is essentially very difficult because high magnetic fields (>2T) are always exerted on samples inside the magnetic objective lens. In recent years, we have succeeded in developing a new magnetic objective lens system that realizes a magnetic field free environment at the sample position [3]. Using this new objective lens system in combination with differential phase contrast imaging technique, real-space visualization of intrinsic magnetic fields of an antiferromagnet has been achieved [4]. This novel electron microscope (Magnetic-field-free Atomic Resolution STEM: MARS) is expected to be used for research and development of many magnetic materials and devices. In this talk, I will show some resent material application using the MARS [5-9] and also introduce the new development project (MAgnetic field-free Cryogenic Atomic resoLUtion electron microscope: MACALU) supported by JST ERATO.

References

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